A comparison of cyanotoxin release following bloom treatments with copper sulfate or sodium carbonate peroxyhdrate.

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Introduction

Nuisance and harmful algal blooms are often controlled by the use of chemical treatments. However, many cyanobacteria retain cyanotoxins within their cell structure, and upon cell lyses (cell death) will release these toxins into the water column. These secondary compounds can be potentially harmful to humans who drink these waters, either from contaminated drinking water reservoirs or from recreational activities (e.g., swimming, water skiing) that promote water ingestion. For example, in the 1970's approximately 150 people (mostly children) in Palm Island, Australia were hospitalized with severe hepatoenteritis and kidney failure. This outbreak was attributed to a cyanotoxin, cylindrospermopsin, which had accumulated in drinking waters following the reservoir's treatment with copper sulfate. In this study, we evaluated both cell-bound and soluble (released following cell lyses) microcystin concentrations, following chemical treatment (with copper sulfate, or sodium carbonate peroxyhydrate; PAK-27^{TM}) of a cyanobacterial bloom dominated by *Microcystis aeruginosa*.

Hypotheses

The application of algaecides will increase the level of soluble (free) microcystins and decrease the level of cell bound microcystins. The degree of algaecide treatment will influence the how much cyanotoxin will be released following treatment.

Methods

Bloom samples (composed primarily of *Anabaena* and *Microcystis*) were incubated in 4 L microcosms. The microcosms were dosed with varying levels of algaecides (low~0.15 ppm, moderate~1.5 ppm, and high~5.0 ppm), of either $CuSO_4$ or PAK-27^{TM}. All microcosms were situated within the lake to insure natural temperature and light regimes. Water samples were collected (100 mL) initially (Day-1), and 10-, 20-, and 30-days post treatment. Samples were analyzed for microcystin-LR using ELISA (Enzyme-Linked ImmunoSorbent Assay) molecular techniques. The water samples were filtered to separate cell-bound and soluble microcystin. The soluble fraction was concentrated to 2.0 mL using solid phase extraction techniques (C-18 silica cartridges; Waters Sep-Pak Plus). The cell-bound fractions, collected on glass fiber filters, were extracted in 80% methanol. Chlorophyll-*a* levels were determined spectrophotometrically.

Results and Conclusion

In this study, we observed significant declines in cell-bound microcystin-LR by Day-10 (by as much as 0.8 µg L^{-1}) and continued through Day-30 (up to 1.8 µg L^{-1}) in copper-treated microcosms. There were no reductions in cell-bound microcystin-LR observed in PAK-27^{TM} treated microcosms. The declines in cell-bound toxins observed in this study indicate that copper sulfate chemically disrupted cyanobacterial cells, thereby releasing toxins into the water column. This release of toxin was observed in the soluble microcystin-LR fraction by Day-20 (by as much as 1.3 µg L^{-1}) for both PAK-27^{TM} and copper treatments. When considering that the World Health Organization (WHO) placed a provisional guideline of 1.0 µg L^{-1} for potable water, it is critical that cyanobacterial blooms be approached with caution when applying chemical treatments. In this study, for example, the increase of soluble toxin was nearly double the recommended level by the WHO.